

APPLICATION FOR  
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SPECIFICATION

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Title of the Invention: DYNAMIC IMAGE COMPOSITION APPARATUS  
AND METHOD

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## **Dynamic Image Composition Apparatus and Method**

### **Cross Reference to Related Application**

This application is a continuation of  
5 International PCT Application No. PCT/JP99/01153  
filed on March 10, 1999.

### **Background of the Invention**

#### **Field of the Invention**

10 The present invention relates to a dynamic  
image composition apparatus for combining one or  
more dynamic images and displaying them on a screen  
and a method thereof.

#### **15 Description of the Related Art**

Recently, with the spread of personal  
computers and workstations, the number of users who  
use the reproduction software of dynamic image data  
to reproduce an image while moving the image on a  
20 screen has been increasing. Conventional  
reproduction software has a function to combine and  
store both the data of an image component to be  
displayed and the data of the movement and to transmit  
the combined data to a plotting device when the image  
25 is reproduced.

However, when a complex movement, such as when an image component moves while vertically vibrating, is reproduced, a last movement must be manually composed in advance. Therefore, to represent a plurality of different complex movements when an image is reproduced, all kinds of movements are composed in advance and each image component is displayed according to a respective predetermined movement when the image is reproduced. Even when a plurality of image components are composed of the same movement element, such as translation, etc., each movement must be individually composed.

As described above, in the conventional reproduction software, a great amount of movement data must be prepared to represent many complex movements. A new movement cannot also be composed when an image is reproduced, nor can a movement also be flexibly modified. Furthermore, the conventional reproduction software has a problem that there is no method for sharing the same movement element with a plurality of image components.

### **Summary of the Invention**

It is an object of the present invention to provide a dynamic image composition apparatus for

improving the versatility of each movement element and for easily representing a complex movement when displaying a plurality of dynamic images on a screen and a method thereof.

5           the dynamic image composition apparatus of the present invention comprises a plurality of plot information generating devices, one or more image management devices and a plotting device, and it combines and displays one or more images.

10           Each plot information generating device generates plot information used to plot a dynamic image. Each image management device manages the image data of each image and generates the plot information at a present time of each image by combining one  
15   or more pieces of plot information generated by one or more of a plurality of plot information generating devices. The plotting device receives both the image data and plot information at a present time from  
20   the image management device and plots the image data based on the plot information at a present time.

#### **Brief Description of the Drawings**

Fig. 1 shows the basic configuration of the dynamic image composition apparatus of the present  
25   invention;

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Fig. 15 shows the third dynamic image

composition;

Fig. 16 is a flowchart showing the second plot update process;

Fig. 17 is a flowchart showing the third plot information generating process;

Fig. 18 shows the fourth dynamic image composition;

Fig. 19 is a flowchart showing the fourth plot information generating process;

Fig. 20 shows the first dynamic image;

Fig. 21 shows the fifth dynamic image composition;

Fig. 22 shows the second dynamic image;

Fig. 23 shows the third dynamic image;

Fig. 24 shows the configuration of an information processing device;

Fig. 25 shows an example of storage media; and

Fig. 26 shows the configuration of the fifth dynamic image composition apparatus.

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### **Description of Preferred Embodiments**

The preferred embodiments of the present invention are described in detail below with reference to the drawings.

Fig. 1 shows the basic configuration of the

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dynamic image composition apparatus of the present invention. The dynamic image composition apparatus shown in Fig. 1 comprises a plurality of plot information generating devices 1, one or more image management devices 2 and a plotting device 3, and it combines and displays one or more images.

Each plot information generating device 1 generates plot information used to plot a dynamic image. Each image management device 2 manages the image data of each image and generates the plot information at a present time of each image by combining one or more pieces of plot information generated by one or more of a plurality of plot information generating devices 2. The plotting device 3 receives both the image data and plot information at a present time from the image management device 2 and plots the image data based on the plot information at a present time.

The plot information are generated for each image and includes information about the position coordinates on a screen of an image. When an image is reproduced, each of the plurality of plot information generating device 1 generates plot information for plotting a different movement element, and the image management device 2 generates

one piece of plot information by combining a plurality of pieces of plot information generated by the plurality of plot information generating devices 1.

5           For example, if the first and second plot information generating device generate plot information for indicating the vertical vibration of a sine wave and plot information for indicating the rightward shift, respectively, plot information  
10           obtained by combining those pieces of plot information indicates a rightward shift with a vertical vibration along the locus of a sine wave.

          The plotting device 3 plots image data based on the plot information composed in this way and  
15           represents a composed movement. If there are a plurality of image management devices 2, the plotting device 3 plots the image data based on plot information corresponding to each piece of image data and combines a plurality of images on a screen.

20           In this way, a complex movement can be easily generated by combining a plurality of pieces of plot information generated by a plurality of plot information generating devices 1, in real time when an image is reproduced. Since the plurality of image  
25           management devices 2 can use one plot information



Alternatively, a plot information generating device 1 can also be handled as a movement component for plotting an individual movement, and a plot information generating device 1 can also be added/deleted according to an event generated while a dynamic image is reproduced. Therefore, the movement of an image can be modified by a user's input operation, etc.

According to the present invention, a plurality of plot information generation units are provided for each image component, and the movement of each image component is composed in real time when an image is reproduced. For plot information,

the position, size, rotation angle, color, sequential relationship, etc., of an image component are used, and the movement of each image component can be determined by providing plot information at each time. A complex movement can be easily generated by combining in real time a plurality of pieces of plot information generated by the plurality of plot information generating units. A movement element can be widely used by enabling the same movement element to be referred by a plurality of plot information generating units.

Fig. 2 shows the configuration of a dynamic image composition apparatus based on absolute plot information. The dynamic image composition apparatus shown in Fig. 2 comprises one or more image management units 11, a plotting unit 12, a VRAM 13 and a display 14.

The image management unit 11 is provided for each image component, and, for example, it passes both image data and plot information at a present time to the plotting unit 12 at appropriate intervals, such as once per frame, etc., or at dynamically determined intervals. The plotting unit 12 writes the image data, received from each image management unit 11, in the VRAM 13 based on the plot information

and displays the data on the screen of the display 14.

The image management unit 11 includes an image source 21, a memory 22 and one or more plot information generating units 23. The image source 21 is, for example, a still image memory, a motion picture image decoder, etc., and it generates image data to be written in the VRAM 13. Therefore, the data in the image source 21 include arbitrary images, such as a still image, motion picture image, character, symbol, etc.

The plot information generating units 23 are linked to one another in an order relation. Each plot information generating unit 23 calculates the absolute plot information at a present time according to a corresponding movement element, adds the calculation result at a present time to the plot information passed by a higher-order plot information generating unit 23 and passes the information to a lower-order plot information generating unit 23.

The highest-order plot information generating unit 23 reads the plot information at a previous time from the memory 22, calculates plot information at a present time based on the information and passes

the information to a lower-order plot information generating unit 23. The plot information at a present time outputted by the lowest-order plot information generating unit 23 is passed to the plotting unit 5 12 and is simultaneously written in the memory 22.

In this case, the order, type and number of the plot information generating units can be fixed or can be dynamically changed according to time, by a user's operation, etc. The plot information 10 generating unit 23 can be configured by software or hardware.

The dynamic image composition apparatus shown in Fig. 2 can be implemented, for example, by the configuration shown in Fig. 3. The dynamic image 15 composition apparatus shown in Fig. 3 further comprises a plot information string management unit 31 in addition to the constituent components shown in Fig. 2.

The plot information string management unit 20 31 stores one or more plot information strings 32, and these plot information strings 32 are identified by identifiers (indexes). The plot information string 32 is a list of a plurality of pieces of plot information at arbitrarily discrete times, and it 25 describes respective pieces of plot information at

Each plot information generating unit 23 stores both an identifier 33 for referring to the plot information string 32 and a modification parameter 34 for modifying plot information. At a specific time, the plot information generating unit 23 extracts two pieces of plot information before and after the time from the plot information string 32 in the plot information string management unit 31 corresponding to the identifier 33. Then, the plot information generating unit 23 calculates plot information at a present time by a method of performing interpolation using the extracted plot information, etc.

15           Then, the plot information generating unit 23  
enlarges or reduces the calculated plot information  
by the parameter 34, adds the calculation result  
at a present time to the plot information passed  
by a higher-order plot information generating unit  
20 23 and passes the information to a lower-order plot  
information generating unit 23. The parameter 34  
can be not only applied to plot information itself,  
but it can also be applied to a time when the plot  
information is extracted. By changing a time in this  
25 way, the movement speed of an image can be changed.

Fig. 4 shows a dynamic image composition apparatus based on the difference between two pieces of plot information. The dynamic image composition apparatus shown in Fig. 4 comprises one or more image management units 11, a plotting unit 12, a VRAM 13 and a display 14 like the dynamic image composition apparatus shown in Fig. 2.

The image management unit 11 includes an image source 21, a memory 22, one or more plot information generating units 41 and adders 42 and 43. Each plot information generating unit 41 calculates the difference in plot information (difference plot information) between a previous time and a present time according to a corresponding movement element, and adds the difference to the adder 43.

The adder 43 totals a plurality of pieces of the difference plot information at a present time outputted by the plot information generating units 41, and the adder 42 obtains plot information at a present time by adding the totaled difference plot information at a present time to plot information at a previous time read from the memory 22. The plot information at a present time outputted from the adder 42 is passed to the plotting unit 12 and is simultaneously stored in the memory 22.

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5 outputs the calculation result to the adder 43.

10 are configured by reproduction software is mainly  
described.

15 information generating units 23 and 41, the program  
of the plotting unit 12, etc., are already read and  
expanded in the memory of a computer. For example,  
if the image source 21 is an MPEG (Moving Picture  
Experts Group) decoder, motion picture data after  
20 image expansion are read into the memory.

25 interruption by the system, etc., and the event is



not limited to a specific form.

Although for the plot update interval, a specific value  $dt$  is used, the same fundamental algorithm can be applied even if an update interval is dynamically changed depending on the function of reproduction hardware, etc. Generally, the longer the update interval, the smaller the plotting frequency and the higher the plotting speed. Therefore, a real time process can be implemented by appropriately adjusting an update interval.

Although for plot information, two-dimensional coordinates corresponding to the position at which an image is displayed are used, the same fundamental algorithm can also be applied, even if other plot information, such as the size, rotation angle, etc., of an image is used.

Although for the data included in the plot information string 32, an identifier, time and two-dimensional coordinate string are used, the overall algorithm does not change, even if information indicating a more complex movement is included. Since the plot information generating units 23 and 41 store respective unique internal times and coordinate spaces, different movements

Fig. 6 shows a dynamic image composition process in the case where a plot information function is used instead of the plot information string 32 in the configuration shown in Fig. 3. The plot information function management unit 51 shown in Fig. 6 stores one or more plot information functions 52 in the form of a list, and these plot information functions 52 can be identified by identifiers.

The plotting unit 12 stores a list 61 of pointers to an arbitrary number of image management units 11, a variable 62 for receiving an event notice and an image update interval 63. A pointer pImagei (i=1,2,...,M) included in the list 61 indicates an image management unit #i.

Each image management unit 11 stores the data 64 of the image source 21, the most recent plot coordinates 65 at a previous time corresponding to the memory 22, the plot coordinates 66 and the highest-order image information generating unit #1, and the plot information generating unit #i ( $i=1, 2, \dots, N-1$ ) stores pointer lpi to a lower-order plot information generating unit #(i+1). However, the lowest-order plot information generating unit

#N stores no pointer to another plot information generating unit 23.

Each plot information generating unit #i ( $i=1,2,\dots,N$ ) stores a plot information function identifier pfk ( $k=1,2,\dots,K$ ), a speed parameter speedi, scale parameters x\_scalei and y\_scalei and an internal time t\_lasti.

Since the identifier pfk corresponds to the plot information function 52 of the plot information function management unit 51, each plot information generating unit 23 can refer to an arbitrary information function 52. Therefore, one plot information function 52 can sometimes be referred by a plurality of plot information generating units 23 in one image management unit 11 and can sometimes be referred by the respective plot information generating units 23 in a plurality of image management units 11.

Fig. 7 is a flowchart showing the plot update process of the dynamic image composition apparatus shown in Fig. 6. M pieces of image data 64 of image management units #1-#M are sequentially plotted on coordinates generated via plot information generating units #1-#N by one plot update process. A loop a corresponds to a process of calling up each

At loop a, the image management unit 11 assigns the last plot coordinates (x\_last, y\_last) at a previous time to plot coordinates (x, y) (step S1) and it performs an event process (step S2). In the event process, event information which is notified to the plotting unit 12 during an update interval dt and stored in a variable Event, is identified and the plot information generating units 23 are dynamically reorganized, if required. The details of this event process are described later.

Then, the image management unit 11 assigns the  
25 obtained coordinates (x, y) to coordinates (x\_last,

y\_last) (step S4), and the plotting unit 12 plots the image data 64 at the position of the coordinates (x, y) (step S5).

When the loop a processes of all image management units 11 are completed, the plotting unit 12 clears the variable Event in order to receive a new event notice (step S6) and terminates the process.

Fig. 8 is a flowchart showing the event process in step S2 shown in Fig. 7. The event information stored in the variable Event of the plotting unit 12 includes both the identifier of the image data 64 and a flag indicating that a new plot information generating unit 23 should be generated or that an existing plot information generating unit 23 should be deleted. The event information also includes additional information for designating a plot information generating unit 23 to be generated/deleted.

On receipt of the event information from the plotting unit 12, the image management unit 11 judges from the identifier whether the image data 64 being processed are the target of the event notice (step S11). If the image data 64 being processed are not the target, the image management unit 11 terminates

5           Here, the image management unit 11 judges whether the flag indicates the addition of a plot information generating unit (step S12). If it is judged that the flag indicates the addition, the image management unit 11 adds a plot information  
10           generating unit 23 designated by the additional information (step S13) and terminates the process. If it is judged that the flag does not indicate the addition, the image management unit 11 deletes a plot information generating unit 23 designated  
15           by the additional information (step S14) and terminates the process.

The complex movement of an image can be  
25 dynamically changed by such a dynamic reorganization

process of plot information generating units 23. For example, by deleting a plot information generating unit 23 only for a single vibration or only for a parallel shift from the image management unit 11 for an image which is obtained by combining the single vibration and parallel shift and which moves in the form of a sine wave, the present movement of the image can be transferred to another simpler movement. By adding a plot information generating unit 23 for single vibration to the image management unit 11 of an image which moves in parallel, the present movement of the image can be transferred to another more complex movement.

Fig. 9 is a flowchart showing the plot information generating process in step S3 shown in Fig. 7. The highest-order plot information generating unit #1 executes a process using both an update interval  $dt$  and plot coordinates  $(x, y)$  as inputs, and outputs updated plot coordinates  $(x, y)$ .

The plot information generating unit #1 first multiplies the update interval  $dt$  by a parameter  $speed1$  to convert a global update interval  $dt$  to the internal update interval  $dt1$  of the plot information generating unit #1 (step S21).

Then, the plot information generating unit #1 obtains a plot information function  $f_1(t_{\text{last}}, dt, x, y)$  corresponding to a plot information function identifier  $p_1$  from the plot information function management unit 51 (step S22). This plot information function obtaining process is described later. Then, the plot information generating unit #1 calculates new plot coordinates  $(x, y)$  according to the following equation using an internal time  $t_{\text{last1}}$  calculated at a previous time, the internal update interval  $dt_1$  and the inputted plot coordinates  $(x, y)$  (step S23).

$$(x, y) = f_1(t_{\text{last1}}, dt_1, x, y) \quad (1)$$

Equation (1) indicates that  $x$  and  $y$  are calculated as functions of  $t_{\text{last1}}$ ,  $dt_1$ ,  $x$  and  $y$ . For  $f_1(t_{\text{last1}}, dt_1, x, y)$ , for example, a function in which  $x=0$ ,  $y=\sin(t_{\text{last1}}+dt_1)$ , is used.

Then, in order to convert the obtained plot coordinates  $(x, y)$  from the internal coordinate space to a global coordinate space,  $x$  and  $y$  are multiplied by a parameter  $x_{\text{scale1}}$  and  $y_{\text{scale1}}$ , respectively, and the results are assigned to  $x$  and  $y$ , respectively (step S24).



Then, the plot information generating unit #1 updates the internal time by assigning  $t\_last1 = t\_last1 + dt1$  (step S25) and judges whether there is a lower-order plot information generating unit 23 (step S26). In this case, if there is a pointer 5  $lp1$  to the lower-order information generating unit 23, it is judged that there is a lower-order plot information generating unit 23. If there is no lower-order plot information generating unit 23, 10 the plot coordinates  $(x, y)$  are outputted as the result of one update process.

If there is a lower-order plot information generating unit 23, the plot information generating unit #1 calls up the lower-order plot information 15 generating unit 23, provides the lower-order plot information generating unit 23 with both the update interval  $dt$  and obtained plot coordinates  $(x, y)$  as inputs and makes the lower-order plot information generating unit 23 execute the same plot information 20 generating process (step S27). In this case, the plot information generating process shown in Fig. 9 is recurrently called up and the process of a plot information generating unit #i is executed.

At this time, the plot information generating 25 unit #i calculates  $dt1 = dt * speed_i$  in step S21, obtains

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The plot information generating unit #i calculates  $x=x \cdot x\_scalei$  and  $y=y \cdot y\_scalei$  in step S24, calculates  $t\_lasti=t\_lasti+dt1$  in step S25 and judges whether there is a pointer  $lpi$  in step S26.

On receipt of the plot coordinates from the lower-order plot information generating unit 23, the higher-order plot information generating unit 23 sequentially passes the plot coordinates to other higher-order plot information generating units 23

By such a plot information generating process,  
5 a plurality of plot information generated by a  
plurality of pieces of plot information generating  
units 23 can be combined in real time and they can  
be supplied to the plotting unit 12. Therefore, the  
complex movement of an image can be easily generated  
10 by automatically repeating the update of the image.

Fig. 10 is a flowchart showing the plot information function obtaining process in step S22 shown in Fig. 9. When the plot information generating unit #i passes the identifier pfk to the plot information function management unit 51, the plot information function management unit 51 executes the loop a process. Loop a is repeated K times in correspondence with the number of plot information functions.

20           In loop a, the plot information function  
management unit 51 compares the inputted identifier  
pfk with the identifier of one plot information  
function 52 (step S31). If the identifiers match,  
the plot information function management unit 51  
25   outputs a plot information function 52 corresponding

to the identifier pfk (step S32) and terminates the process. If the identifiers do not match, the plot information function management unit 51 repeats a process of comparing the identifier pfk with the identifier of a subsequent plot information function 52.

Fig. 11 shows a dynamic image composition process in the case where the configuration shown in Fig. 3 is used. The plot information string management unit 31 shown in Fig. 11 stores one or more plot information strings 32 in the form of a list, and these plot information strings 32 are identified by identifiers. Each plot information string 32 includes a string of discrete times and plot coordinate values.

The list 61, event variable 62 and update interval 63 of the plotting unit 12, and the image data 64, last plot coordinates 65 and plot coordinates 66 of the image management unit 11 are the same as those shown in Fig. 6. Each plot information generating unit #i ( $i=1,2,\dots,N$ ) stores an information string identifier IDk ( $k=1,2,\dots,K$ ) instead of the plot information function identifier shown in Fig. 6.

Since the identifier IDk corresponds to the

The plot information generating unit #i stores a difference calculation flag bDiffi as one of the parameters. The plot information generating unit #i adds a difference to inputted plot coordinates and outputs the coordinates if this bDiffi value is true, and it outputs absolute plot coordinates regardless of inputted plot coordinates if the bDiffi value is false.

The plot update process of the dynamic image composition apparatus shown in Fig. 11 is basically the same as that shown in Fig. 7. However, in step S3 shown in Fig. 7, the highest-order plot information generating unit #1 executes the plot information generating process shown in Fig. 12 using both an update interval  $dt$  and plot coordinates  $(x,$

The plot information generating unit #1 first converts the update interval  $dt$  to an internal update interval  $dt1$  by multiplying the update interval  $dt$  by a parameter  $speed1$  (step S41) and obtains a plot information string corresponding to a plot information string identifier ID1 (step S42). This plot information string obtaining process is described later.

For example, if the plot information string  
20 shown in Fig. 13 is obtained, the difference (dx,  
dy) is calculated as follows. However, it is assumed  
that  $t_1 < t_2 < t_3 < \dots < t_J$  is satisfied,  $x_1, x_2, x_3, \dots,$   
 $x_J$  are different and  $y_1, y_2, y_3, \dots, y_J$  are different.

First, in the case of

25  $t_1 < t_{\text{last1}} < t_{\text{last1}} + dt_1 < t_2$ , the difference  $(dx, dy)$

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In the case of  $t_1 < t_{last1} < t_2 < \dots < t_j < t_{last1} + dt_1 < t_{(j+1)}$ , the difference  $(dx, dy)$  is calculated according to the following equations.

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dx=(x2-x1)*(t2-t_last1)/(t2 - t1)
+xj-x2
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$$(4) \quad \begin{aligned} & + (x(j+1) - x_j) * (t_{last1} + dt1 - t_j) / (t(j+1) - t_j) \\ & dy = (y2 - y1) * (t2 - t_{last1}) / (t2 - t1) \\ & + y_j - y2 \end{aligned}$$

$$+ (y(j+1) - y_j) * (t\_last1 + dt1 - t_j) / (t(j+1) - t_j)$$

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$$dx = (x_J - x_{(J-1)}) * (t_J - t_{last1}) / (t_J - t_{(J-1)})$$

(5)

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(6)

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difference (dx, dy) to inputted plot coordinates (x, y) and assigns the result to the coordinates (x, y) (step S46). If the value of the flag bDiff1 is false, the plot information generating unit #1  
5 assigns the difference (dx, dy) to the coordinates (x, y) with no addition (step S47). In this case, the inputted plot coordinates (x, y) are cancelled and new coordinates (x, y) are generated.

Then, the plot information generating unit #1  
10 updates the internal time by assigning  $t\_last1 = t\_last1 + dt1$  (step S48) and judges whether there is a lower-order plot information generating unit 23 (step S49). If there is no lower-order plot information generating unit 23, the plot information  
15 generating unit #1 outputs the plot coordinates (x, y) as a result of one update process.

If there is a lower-order information generating unit 23, the plot information generating unit #1 calls up the lower-order information  
20 generating unit 23, provides the lower-order information generating unit 23 with both the update interval dt and obtained plot coordinates (x, y) as inputs and makes the lower-order information generating unit 23 execute the same plot information  
25 generating process (step S50). In this case, the

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On receipt of the plot coordinates from the lower-order plot information generating unit 23, the higher-order plot information generating unit 23 sequentially passes the plot coordinates to another higher-order plot information generating unit 23. The highest-order plot information generating unit #1 outputs the received plot coordinates as a result of one update process. By such a plot information generating process, the plot information generating unit 23 can generate plot information using a plot information string instead of a plot information function.

Fig. 14 is a flowchart showing the plot information string obtaining process in step S42 shown in Fig. 12. When the plot information generating unit #i passes the identifier IDk to the plot information string management unit 31, the plot information string management unit 31 executes a loop a process. Loop a is repeated K times corresponding to the number of the plot information strings 32.

In loop a, the plot information string management unit 31 compares the inputted identifier IDk with the identifier of one plot information string 32 (step S51). If the identifiers match, the

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plot coordinates 65 and plot coordinates 66 of the  
image management unit 11; information stored in the  
plot information generating units 41; and the plot  
information function management 51 which are all  
5 shown in Fig. 15 are the same as those shown in Fig.  
6.

Each image management unit 11 also stores  
difference coordinates 67 and further stores one  
or more plot information generating units 41 in the  
10 form of a list.

Fig. 16 is a flowchart showing the plot update  
process of the dynamic image composition apparatus  
shown in Fig. 15. By one plot update process, M pieces  
of image data of the image management units #1-#M  
15 are sequentially plotted on coordinates generated  
by the plot information generating units #1-#N. A  
loop a corresponds to a process of calling up each  
image management unit 11 and is repeated M times.  
A loop b corresponds to a process of calling up each  
20 plot information generating unit 41 and is repeated  
N times.

In loop a, the image management unit 11 executes  
the event process shown in Fig. 8 (step S61), assigns  
the last plot coordinates (x\_last, y\_last) at a  
25 previous time to plot coordinates (x, y) (step S62)

and executes the process of loop b.

In loop b, the plot information generating unit 41 is called up, and coordinate change difference (dx, dy) during an update interval dt is calculated (step S63). The details of this plot information generating process are described later. Then, the obtained difference (dx, dy) is added to the plot coordinates (x, y), and the result is assigned to the plot coordinates (x, y) (step S64).

As for loop b, lower-order plot information generating units #(i+1) can be sequentially called up tracing a pointer lpi from the highest-order plot information generating unit #1 or the plot information generating units #1-#N can be operated in parallel.

After the loop b processes of all plot information generating units 41 are completed, the image management unit 11 assigns the obtained coordinates (x, y) to coordinates (x\_last, y\_last) (step S65), and the plotting unit 12 plots the image data 64 at the position of the plot coordinates (x, y) (step S66).

After the loop a processes of all image management units 11 are completed, the plotting unit 12 clears the variable Event to receive a new event

notice (step S67) and terminates the process.

Fig. 17 is a flowchart showing the plot information generating process in step S63 shown in Fig. 16. The plot information generating unit #i executes a process using an update interval  $dt$  as an input and outputs a plot coordinate difference  $(dx, dy)$ .

The plot information generating unit #i first multiplies the update interval  $dt$  by a parameter  $speed_i$  and converts the update interval  $dt$  to an internal update interval  $dt1$  (step S71). Then, the plot information generating unit #i obtains a plot information function  $fk(t)$  corresponding to a plot information function identifier  $pfk$  from the plot information function management unit 51 by executing the plot information function obtaining process shown in Fig. 10 (step S72). Here, it is assumed that  $fk(t)$  is expressed by the following equation.

$$fk(t) = (fkx(t), fky(t)) \quad (7)$$

The plot information generating unit #i calculates the difference  $(dx, dy)$  according to the following equation using both an internal time  $t\_last1$  calculated at a previous time and the internal update



interval dt1 (step S73).

$$\begin{aligned} dx &= f_{kx}(t_{lasti} + dt1) - f_{kx}(t_{lasti}) \\ 5 \quad dy &= f_{ky}(t_{lasti} + dt1) - f_{ky}(t_{lasti}) \end{aligned} \quad (8)$$

Equation (8) indicates the respective differences of functions  $f_{kx}(t)$  and  $f_{ky}(t)$  between  
10 internal times  $t_{lasti}$  and  $t_{lasti} + dt1$ .

Then, the plot information generating unit #i multiplies the obtained differences (dx, dy) by parameters  $x\_scalei$  and  $y\_scalei$ , respectively, and the results are assigned to the differences dx and  
15 dy, respectively (step S74). Then, the plot information generating unit #i updates the internal time by assigning  $t_{lasti} = t_{lasti} + dt1$  (step S75), outputs the difference (dx, dy) and terminates the process.

20 The difference (dx, dy) outputted by each plot information generating unit #i is added to the plot coordinates (x, y) in step S64 shown in Fig. 16 and lastly the plot coordinates (x, y) are updated by the sum of differences (dx, dy) outputted by all  
25 plot information generating units 41.

By such a plot information generating process, a plurality of pieces of plot information generated by a plurality of plot information generating units 41 can be combined in real time when an image is updated and they can be provided to the plotting unit 12. Therefore, the complex movement of an image can be easily generated by automatically repeating the update of the image.

Fig. 18 shows the dynamic image composition process in the case of the configuration shown in Fig. 5. The pointer list 61, event variable 62 and update interval 63 of the plotting unit 12; and the image data 64, last plot coordinates 65, plot coordinates 66 and difference coordinates 67 of the image management unit 11 shown in Fig. 18 are the same as those shown in Fig. 15. Both pieces of information stored in the plot information generating unit 41 and the plot information string management unit 31 are the same as those shown in Fig. 11. However, the plot information generating unit 41 does not store a difference calculation flag.

The plot update process of the dynamic image composition apparatus shown in Fig. 18 is basically the same as that shown in Fig. 16. However, in step S63 shown in Fig. 16, the plot information generating

5           The plot information generating unit #i first multiplies the update interval dt by a parameter speed<sub>i</sub>, converts the update interval dt to an internal update interval dt<sub>1</sub> (step S81) and obtains a plot information string corresponding to a plot information identifier ID<sub>k</sub> from the plot information string management unit 31 by executing the plot information string obtaining process shown in Fig. 14 (step S82).

Then, the plot information generating unit #i multiplies the obtained differences dx and dy by parameters x\_scalei and y\_scalei, respectively, and assigns the results to the differences dx and dy (step S84). Then, the plot information generating

unit #i updates an internal time by assigning  
t\_lasti=t\_lasti+dt1 (step S85), outputs a  
difference (dx, dy) and terminates the process. By  
such a plot information generating process, the plot  
5 information generating unit 41 can generate plot  
information using a plot information string instead  
of a plot information function.

Although in the preferred embodiments  
described above, the pointer 61 to the image  
10 management unit 11, plot information generating  
units 23 and 41, plot information function 52 and  
plot information string 32 are stored in the form  
of a list, these can be stored in an arbitrary form  
only if it is a structure where an element can be  
15 added/deleted.

Next, the specific example of dynamic image  
composition is described with reference to Figs.  
20 through 23.

Fig. 20 shows a screen structure at time t=0.  
20 On this screen, an xy coordinate system having the  
upper left corner as an origin is established and  
three images I1, I2 and I3 are plotted in a state  
where a plot position (x, y) is changed as time  
elapses.

25 Fig. 21 shows the dynamic image composition

process by image management units 11 for managing these images. In this example, the dynamic image composition apparatus shown in Fig. 5 is used and both a plot information function 52 and a plot information string 32 are used.

The image management unit 11 of image I1 stores image data 64, the most recent plot coordinates (x1, y1) and two plot information generating units #1 and #2, the image management unit 11 of image I2 stores image data 64, the most recent plot coordinates (x2, y2) and one plot information generating unit 41, and the image management unit 11 of image I3 stores image data 64, the most recent plot coordinates (x3, y3) and one plot information generating unit 41.

The plot information generating unit #1 of image I1 stores a plot information function identifier pf1, and the plot information generating unit #2 stores a plot information function identifier pf2. The plot information generating unit 41 of image I2 stores a plot information function identifier pf2, and the plot information generating unit 41 of image I3 stores a plot information string identifier ID1.

Each plot information generating unit 41

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10

$$dy = 100 * (\sin(t\_last + dt) - \sin(t\_last)) \quad (9)$$

15

20

$$dy=0 \quad (10)$$

25

difference  $dx$  is equal to ten times the update interval  $dt$  and a  $y$ -direction difference is 0. As a result, this function indicates a linear shift which is made by 10 shifts per unit time in the

5  $x$ -direction (rightward).

The plot information string 32 includes position coordinates for the four vertices of a square with each side of 100, and a locus designated by the plot information string 32 indicates a

10 clockwise shift along the four sides of the square with an upper left vertex as a start point. In this case, the difference  $(dx, dy)$  is calculated based on the designated locus by performing a linear interpolation.

15 Each image management unit 11 calculates position coordinates  $(x, y)$  as follows using the difference  $(dx, dy)$  calculated by these plot information functions 52 or plot information strings 32.

20 -Image management unit 11 of image I1

The plot information generating unit #1 calculates the difference of a vertical vibration using a plot information function  $pfl$  and the plot information generating unit #2 calculates the

25 difference of a rightward shift using a plot

```
5  -Image management unit 11 of image I2
```

```
-Image management unit 11 of image I3
```

Here, a case is considered where in such a dynamic image composition process, notification of a specific event is posted at time  $t=1$  and an event process is executed. In this case, at time  $t=0$ , each image is plotted in the initial position, as shown in Fig. 20. Between times  $t=0$  and  $t=1$ , each image



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10

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of a square.

If the content of the event notification at time  $t=1$  is a request to add a new plot information generating unit #3 to the image management unit 11 of image I1, the image management unit 11 adds the plot information generating unit #3. After this, differences generated by three plot information generating units #1, #2 and #3 are added and the position coordinates of image I1 is determined.

By the way, the dynamic image composition apparatuses shown in Figs. 6, 11, 15 and 18 can be configured using an information processing device (computer) shown in Fig. 24. The information processing device shown in Fig. 24 comprises a CPU (central processing unit) 71, a memory 72, an input device 73, an output device 74, an external storage device 75, a medium driving device 76 and a network connection device 77, which are connected to one another by a bus 78.

The memory 72 includes, for example, a ROM (read only memory), RAM (random access memory), etc., and it stores a program and data used for the process. The CPU 71 performs necessary processes by using the memory 72 and executing the program.

In these examples, the image management unit

11, plotting unit 12, image information function management unit 51, image information string management unit 31, image information generating units 23 and 41, etc., correspond to software components described by the program, and each component is stored in the specific program code segment of the memory 72. The list of pointers 61, event variable 62, update interval 63, image data 64, last plot coordinates 65, other plot coordinates 66, etc., are also stored in the memory 72.

The input device 73 includes, for example, a keyboard, a pointing device, touch panel, etc., and it is used to input a user's instruction and information. Notification of an input operation to the input device 73 is also sometimes made to the plotting unit 12 as an event. The output device 74 includes, for example, the VRAM 13 and display 14 shown in Fig. 5, and it is used to output both inquiries to a user and composed dynamic images.

The external storage device 75 includes, for example, a magnetic disk device, optical disk device, magneto-optical disk device, etc. This external storage device 75 can also store the program and data described above, and the program and data can be used by being loaded into the memory 72, if required.

5           The medium driving device 76 drives a portable storage medium 79 and accesses the recorded content. For the portable storage medium, an arbitrary computer readable storage medium, such as a memory card, floppy disk, CD-ROM (compact disk read only memory), optical disk, magneto-optical disk, etc., is used. The program and data described above can also be stored in this portable storage medium 79, and can also be used by being loaded into the memory 72, if required.

10

15           The network connection device 77 communicates with external devices via an arbitrary network (line), such as a LAN (local area network), etc., and transmits/receives data accompanying the communications. The connection network device can also receive the program and data from an external device and the program and data can be used by being loaded

20

into the memory 72, if required.

Fig. 25 shows examples of computer readable  
25 storage media which can provide the information

processing device shown in Fig. 24 with the program and data. The program and data stored in the portable storage medium 79 or an external database 80 can be loaded into the memory 72. The CPU 71 executes  
5 necessary processes by using the data and running the program.

Although in the preferred embodiments described above, configurations for implementing the image management unit 11 by software have been  
10 described, the image management unit 11 can also be implemented by hardware.

Fig. 26 shows a case where a plurality of image management units 11 are configured by one hardware circuit. The image management unit shown in Fig.  
15 26 comprises a plurality of memories 81 (#1-#M), selectors 82 and 83 for selecting a memory 81, a plurality of plot information generating circuits 84 (#1-#N), selectors 85 and 86 for selecting a plot information generating circuit 84 and a control  
20 circuit 87.

The control circuit 87 switches between the selectors 82 and 83 by a control signal C1, switches between the selectors 85 and 86 by a control signal C2 and controls the plot information generating  
25 circuits 84 by a control signal C3. In this example,

it is assumed for simplification purposes that only coordinates  $(x, y)$  are handled as plot information.

The memories #1-#M correspond to the image management units #1-#M, respectively, described above and they store plot information obtained at a previous time at time  $t$ . The plot information generating circuits #1-#N correspond to the plot information generating units #1-#N, respectively, and are described above and perform a calculation corresponding to one movement element and output the plot information. If the time  $t$ , an update interval  $dt$  and plot coordinates  $(x, y)$  at the previous time are used as input, outputted plot coordinates  $(x', y')$  are expressed as follows.

$$\begin{aligned} x' &= fx(t, dt, x, y) \\ y' &= fy(t, dt, x, y) \end{aligned} \quad (11)$$

Above,  $dt$  corresponds to the difference between the previous time and the present time  $t$ , and  $fx(t, dt, x, y)$  and  $fy(t, dt, x, y)$  correspond to functions to generate an image movement. For example, if a vertical vibration is generated using  $\sin(t)$ , the following equations hold true.

$$f_y(t, dt, x, y) = y + \sin(t) - \sin(t - dt) \quad (12)$$

5 of past plot coordinates. For example, input coordinates  $(x_{t1}, y_{t1})$  at time  $t1$  can be stored, and a function to continue to output the coordinates  $(x_{t1}, y_{t1})$  after time  $t1$  can be defined.

10 circuit 84 is used for a plurality of images, such  
plot coordinate data are stored in a register of  
the plot information generating circuit 84 for each  
image, and appropriate data are outputted by  
switching the register by a control signal C3 from  
15 the control circuit 87.

t, first the selectors 82 and 83 are switched over by a control signal C1 from the control circuit 87 and a memory #1 is selected. Then, the selectors 85 and 86 are switched over by a control signal C2 and a plot information generating circuit #1 is selected. Simultaneously, the register of the plot information generating circuit #1 is switched by a control signal C3, if required, and appropriate data are selected. In this way, the plot coordinates

5           Then, the selectors 85 and 86 are switched over,  
a plot information generating circuit #2 is selected  
and the plot information is inputted from the memory  
#1 to the plot information generating circuit #2.  
Then, plot coordinates are generated in the plot  
10 information generating circuit #2 in the same way  
as in the case of the plot information generating  
circuit #1, and the plot coordinates are stored in  
the memory #1. After such an operation is repeated  
for all plot information generating circuits 84  
15 assigned to the image management unit #1, the output  
of the last plot information generating circuit 84  
is outputted as the plot information at the present  
time of the image management unit #1. At this time,  
the plot information is simultaneously stored in  
20 the memory #1.

After the operation of the image management unit #1 is completed in this way, the selectors 82 and 83 are switched over, the memory #2 is selected and the operation of the image management unit #2 is performed in the same way. After such an operation



For example, a case is described where the image management unit #1 corresponding to the memory #1 generates a rightward shift along the locus of a sine wave and the image management unit #2 corresponding to a memory #2 generates a leftward shift along the locus of a sine wave. It is assumed that plot information generating circuits #1, #2 and #3 generate the following respective movements.

```

          Plot    information    generating    circuit    #2:
Rightward linear shift
15          Plot    information    generating    circuit    #3:
Leftward linear shift

```

In this case, the circuit shown in Fig. 26 first selects a memory #1 using the selectors 82 and 83, and it selects a plot information generating circuit #1 using the selectors 85 and 86. In this way, the vertical vibration of  $\sin(t)$  is added to the coordinates of the memory #1. Then, the circuit selects a plot information generating circuit #2 using the selectors 85 and 86. In this way, a rightward shift is added to the plot coordinates of a memory

Then, the circuit selects a memory #2 using  
5 the selectors 82 and 83 and it selects the plot  
information generating circuit #1 using the  
selectors 85 and 86. In this way, the vertical  
vibration of  $\sin(t)$  is added to the plot coordinates  
of the memory #2. Then, the circuit selects a plot  
10 information generating circuit #3 using the  
selectors 85 and 86. In this way, a leftward shift  
is added to the coordinates of the memory #2, and,  
as a result, plot coordinates in the case where the  
plot coordinates move leftward along the locus of  
15 a sine wave are outputted.

In this way, by switching both the memories 81 and plot information generating circuits 84 using selectors, the outputs of a plurality of plot information generating circuits 84 can be combined and one image movement can be generated. One plot information generating circuit 84 can also be used to generate a plurality of image movements.

As described above, the present invention is applicable to an arbitrary field, software or hardware, where a dynamic image moves as time elapses

- (1) Dynamic image generation software
- (2) Home page generation software and browser

5 software

(2) Home page generation software and browser

5 software

(3) CD-ROM content generation software and

(4) Presentation generation software and

(5) Game generation software and game software

For example, in a conventional multimedia

15 vibration with a rightward shift is given, the  
combined result of the two movements must be  
anticipated and prepared in advance.

However, according to the system of the present

invention, a vertical vibration with a rightward  
20 shift can be composed by separately generating a  
rightward shift and a vertical shift and by linking  
both to one image component when an image is  
reproduced. If this system is adopted, a movement  
can be dynamically added /deleted according to a  
25 user's instruction or time.

According to this system, since a rightward shift and a vertical vibration are separately managed when an image is reproduced, a movement in which the image starts moving rightward while vertically vibrating when the image which is moving rightward is clicked, and in which the image stops vertically vibrating when the image is clicked again, can be easily generated. In this case, the system can be configured in such a way that first a rightward shift is linked to an image component as a fundamental movement and a vertical vibration is added/deleted by a click event. According to the conventional system, a rightward shift and a rightward shift with a vertical vibration are separately configured and they are switched over by a click. However, if the two movements are prepared without concern to the continuity, there is a possibility that the two movements may be discontinued when they are switched over.

If the system of the present invention is adopted, a multimedia title producer can handle each movement as a component. Since each kind of movement element is recorded in the completed multimedia title in a disassembled state, another producer can extract his/her favorite movement element from the

multimedia title and can use the element as a movement component.

For example, it can be considered that a multimedia title including an image which moves along a specific path while vertically vibrating in a specific frequency includes two movement components, that is, a vertical vibration with a frequency and a shift along a path. In this case, the vertical vibration with a frequency can be implemented even in another multimedia title by extracting and using only the vertical vibration with the frequency. However, according to the conventional system, since a movement is composed in advance when the multimedia title is produced, it is very difficult to extract only the vertical vibration with a frequency.

Although in the preferred embodiments described above, for a plot information function, the vertical vibration of a sine wave and a leftward/rightward linear shift are used, another arbitrary function can also be used. For example, the vibration of a cosine wave, a shift along a straight line  $y=ax+b$ , a shift along a parabola, a shift along a circle/ellipse and the like can also be defined as a function. A plot information string is not limited to the locus of a square, and the

Furthermore, plot information generated by a  
5 plot information generating unit is not limited to  
the plot position of an image and it can also be  
the enlargement/reduction ratio, rotation angle,  
color, sequential relationship, etc., of an image  
component. A more complex dynamic image can be  
10 displayed by dynamically combining these pieces of  
information.

According to the present invention, when a plurality of dynamic images are displayed on a screen, a complex movement can be easily generated by combining a plurality of movement elements. For example, a movement can be added/deleted in real time according to an event, a movement can be stopped or one movement element can be applied to a plurality of images.